Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

LUMINARY Memo #88

TO: Distribution
FROM: D. Eyles
DATE: June 11, 1969
SUBJECT: LUMINARY Anomaly #64

Due to some stupid coding in the "master ignition routine" if a hardware or software restart occurs between P63 commanded ignition and throttle-up (26 seconds, or Z00MTIME, later) the LGC will fail to take two important actions:

1) Throttle up
2) The placing of the 2CADR of LUNLAND into AUGEXIT to bring the landing guidance equations into the SERVICER loop.

The work-around procedure must take care of these items and clean up after itself:

1) 26 seconds (i.e. ZOOMTIME) after ignition the engine must be throttled-up manually to maximum. Do not put the THR CONT switch into manual as this is unnecessary (since the engine sums the manual and auto throttle signals) and would cause switching into P67 after step (2) is performed. This manual throttle-up must be done closely on time, better slightly early than late. Each second of delay in throttle-up means 12-16 seconds delay in throttle-down. Since nominal throttle-down may be as close as 60 seconds to the end of P63 no more than a 3 second delay is safe - if the hi-gate target conditions are to be met and visibility achieved at the beginning of P64. Time this action using the event timer. If the restart occurs near the end of the trim period quick reaction is required.

2) Next the ADRES half of AVGEXIT must be loaded through the DSKY. (The BBCON half is always already right.) This requires the following 16 keystrokes:

V21 N 1 E 1252 E 2462 E

The slightest mistake makes havoc. This step is not as urgent as (1); it should be done within one minute of throttle-up. The guidance equations normally call for no throttle change and only 8^{o} attitude change in their first 60 seconds. Once this step is performed the burn is guided. This should be verified by observing an immediate pitch change on the FDAI (12^{o} if step (2) comes 60 seconds after step (1)) and time-to-go change in noun 68. There is no harm, though I think little advantage, in one of the crew manually flying the nominal pitch profile while AVGEXIT is being loaded by the other.

3) Finally, after a further wait of at least 4 seconds the manual throttle must be returned to minimum to give throttle-control to the auto-throttle. If this resetting is not done by throttle-down time the throttle is in effect stuck at the top and the consequence of that as everyone knows by now is that about 40 seconds later the guidance equations will command the LM to thrust downwards.

This work-around must be executed with extreme care and no omissions.

The next page is a matrix of test data, including the nominal case and runs with throttle down 3 seconds early and late. These runs are acceptable. Unacceptable is the fourth run, with throttle-up 4.79 seconds late. High gate is missed and the site becomes visible 30 seconds later in the approach phase than nominally.

	Nom	Early	Late	Later
Commanded Ignition	356969.47s	356969.48s	356969.48s	356969.48s
Restart	none	356970.09s	356970.09s	356970.09s
Throttle-up	356995.47s	356992.51s early 2.96s	356998.51s late 3.04s	357000.26s late 4.79s
First Guidance Pass	357995.57s	357057.58s	357063.58s	357063.58s
Throttle-down Pass	357391.57s	357371.58s	357413.58s	357429.58s*
End of P63 — speed	522.8 f/s	520.2 f/s	531.3 f/s	700.5 f/s
End of P63 — altitude rate	-144.4 f/s	-142.1 f/s	-139.8 f/s	-174.5 f/s
End of P63 — altitude	7798 F	7704 F	8080 F	8936 F
Touchdown	357647.17s	357656.27s	357631.26s	357607.37s
DPS Fuel Left	991 lbs	978 lbs	1075 lbs	1239 lbs

* 9th pass of P64

Figure 1